Preventive Veterinary Medicine, 8 (1990) 141-156
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

Economics of Disease Occurrence and Prevention on California Dairy Farms: A Report and Evaluation of Data Collected for the National Animal Health Monitoring System, 1986–87

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ABSTRACT

Sischo, W.M., Hird, D.W., Gardner, I.A., Utterback, W.W., Christiansen, K.H., Carpenter, T.E., Danaye-Elmi, C. and Heron, B.R., 1990. Economics of disease occurrence and prevention on California dairy farms: a report and evaluation of data collected for the National Animal Health Monitoring System, 1986-1987. *Prev. Vet. Med.*, 8: 141-156.

A stratified random sample of 43 dairy herds in California was studied for 1 year as a component of the National Animal Health Monitoring System (NAHMS). Costs associated with clinical disease and disease prevention were determined and the resulting costs extrapolated to the entire California dairy industry.

Cost of disease for herds in our study was \$1.749 million (U.S. dollars), or \$111.68 per cow-year; 52% of the cost was the result of culling of affected animals, and 24% was due to animal death. Calf disease represented 4% of the cost of all disease. Diarrhea and pneumonia were responsible for 86% of calf disease costs. Cow disease accounted for 92% of the total disease costs. Clinical mastitis and infertility accounted for 53% of cow disease costs.

Cost of disease prevention for the 43 herds in our study was \$171 616, or \$10.72 per cow-year. Most of the prevention cost was due to purchase of drugs and biologics.

The estimated cost of clinical disease and disease prevention extrapolated to all California dairies was \$118 million for the 1-year period studied. Clinical mastitis and infertility were estimated to cost California dairy farmers \$52 million. The cost of disease and disease prevention was 6.6% of the value of milk production in the state of California. These estimates were based on observed clinical disease and did not account for the cost of subclinical disease. Recommendations are presented to improve the value of the NAHMS data to industry.

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0167-5877/90/\$03.50

INTRODUCTION

Disease is an important factor limiting the profitability of individual food animal enterprises. In the U.S.A., the annual cost of livestock diseases has been estimated to be more than $14 billion dollars (King, 1981); over $2 billion has been attributed to disease in dairy cattle (Bohlender, 1986). The cost of disease is often studied in the context of epidemics, as the impact is more easily measured. Endemic disease – often considered a substantial cause of decreased production – is studied less often. Evaluation of costs of endemic disease is usually accomplished by studying an individual herd. Studies of multiple farms with results generalizable to a larger population are rare. The National Animal Health Monitoring System (NAHMS) was conceived to fill this gap and to provide valid estimates of disease incidence and costs of livestock disease that could be generalized regionally and nationally.

In this paper, we describe and evaluate the reported cost of clinical disease and preventive measures on 43 California dairies for 1986–87 as part of the NAHMS.

MATERIALS AND METHODS

Sampling methodology has been described previously (Gardner et al., 1990). Briefly, 45 herds were selected from a computerized list of 2679 California diary herds by stratified random sampling based on herd size (Schaeffer et al., 1986). This sample size was determined by the number of personnel available from government agencies involved in data collection and was guided by previous work which demonstrated sample size requirements for making precise estimates of production parameters for California dairies (Akhtar et al., 1988). Three herd-size strata were designated: 1–199 cows ($n=1001$); 200–499 cows ($n=1043$); 500 or more cows ($n=635$). A computer-generated list of random numbers was used to select 17, 17 and 11 herds, respectively, from the three strata.

Owners of selected herds were visited by the local Veterinary Medical Officer (VMO) from either the California Department of Food and Agriculture or the U.S. Department of Agriculture. The VMOs explained objectives, methods, and benefits of participation in the NAHMS, and solicited cooperation from the owner at this initial visit. If the owner was unwilling to cooperate, the herd geographically closest to the original herd and of a similar size was selected as a replacement.

Farms were visited at least monthly by VMOs. During these visits, the VMOs collected information on livestock inventory, disease events, mortality, economic losses attributable to disease events, treatments associated with disease, and preventive costs. This information was based on producer reporting, usually a combination of existing farm records [including Dairy Herd Improvement (DHI) records and records maintained expressly for the NAHMS] and owner/herdsman memory. Description of disease events was based on producer observation, augmented by occasional support provided by diagnostic laboratories, VMOs or private practitioners. The value of labor, dead or culled animals, and milk loss was based solely on producer estimates.

For inventory calculations, calves were defined as animals from birth to weaning, young stock as cattle from weaning to sale or until heifers calved. Females were classified as cows after they calved and bulls were males used for breeding.

Expenditures were divided into three classes: costs associated with disease occurrence, costs associated with disease prevention, and costs not assigned to either occurrence or prevention of disease conditions (miscellaneous costs). Costs associated with disease were divided further into nine categories and costs of prevention and miscellaneous costs were each divided into three categories (Appendix 1).

Economic data in this report are presented in four ways: as total expenditures for all herds, as total expenditures by herd-size stratum, as costs per animal-year for all herds, and as costs per animal-year by herd-size stratum.

Within-stratum costs for cows and young stock per animal-year were calculated by summing costs for an expenditure for all farms within the stratum and dividing it by the animal-years at risk in the stratum. Costs per calf were calculated using calf-months at risk. Costs per animal-year for the entire sample were determined by weighting the within-stratum costs per animal-year according to the proportion that the herd-size stratum assumed in the sampling scheme, and then summing the weighted costs.

Three commonly reported diseases in the present study – mastitis, female infertility and calf diarrhea – were analyzed to determine the between-farm variation in reporting of disease and prevention costs. Mastitis for this analysis was all reported occurrences of mastitis associated with *Streptococcus* sp. or *Staphylococcus* sp., coliform mastitis, and mastitis where no agent was specified. Female infertility was defined as anestrus cows and cows not pregnant more than 150 days since last calving. Calf diarrhea included diagnoses of colibacillosis, enteritis, and diarrhea. For each condition, disease occurrence costs (deaths, drugs, veterinary cost, culls, disposal, and production loss) were expressed per animal-month and per affected animal per farm. Preventive costs (drugs, veterinary costs, and appropriate miscellaneous costs) were expressed per animal-month per farm. The between-farm variation in reported values of dead animals was also determined.

Extrapolation of costs from our sample to all California diary farms was derived from the per animal-year stratum estimates. These stratum estimates were multiplied by the average herd size of the strata. This resulted in an average cost per herd-year within the stratum of interest. This average cost per herd-year was multiplied by the known number of herds in each stratum. This resulted in the estimated annual cost to all California dairies within the stratum. An estimate of costs for all California dairies was obtained by summing the three strata estimates.

Estimates of milk production and the value of milk production were calculated by multiplying the average production per cow per day within a stratum by the average herd size of the stratum multiplied by the actual number of dairies within the stratum. Estimates were standardized to a 305-day lactation. The resulting number was the estimate of milk production for California dairies within a stratum. Total production for the state was estimated by summing the estimates of the three strata.

RESULTS

Sample

Of the 45 originally selected herds, only 24 (53%) were enrolled in the program; 21 replacement herds were required. Herd owners declined to participate because they believed the program did not offer any tangible benefits, or they feared government programs, or they had insufficient time to collect required data. Two herds were lost to the study because of the Dairy Herd Termination Program (a federally sponsored program to reduce numbers of dairy cows). The final sample consisted of 43 herds with 13, 19, and 11 herds in the small, medium, and large herd-size strata, respectively. Data were collected for 12 months from 35 herds, 11 months from seven herds, and 10 months from one herd, and were gathered by 22 VMOs who monitored from one to five herds each.

Costs associated with disease occurrence

The total reported costs for calf, young stock, cow, and bull diseases was $1.749 million, or $111.68 per cow-year. Losses were similar in the three herd size strata (Table 1).

Fifty-two per cent of the cost of disease was due to culling ($58.17 per cow-year in the herd) and 24% was associated with animal deaths ($27.13 per cow-year in the herd). Drugs used to treat disease accounted for 4% of the total costs ($4.50 per cow-year in the herd), and veterinary services accounted for less than 2% of all attributable costs or $2.07 per cow-year in the herd (Table 1).

Cow diseases contributed the greatest proportion (92%) of the overall disease cost. Calf diseases and young stock diseases each accounted for approximately 4% of the total reported costs. Disease in bulls was rarely reported during the NAHMS survey and accounted for less than $2000 (Table 2).

Deaths contributed the major part of costs for diseases affecting calves and young stock. This category accounted for 54% of the cost of calf disease and

TABLE 1

Cost (in U.S. dollars) of disease by category of expenditure and herd size for 43 California dairy farms (NAHMS, 1986-87)

Herd stratum[a]	Death	Cull	Weight loss	Veterinary	Drugs	Disposal	Labor	CBD[b]	Milk loss	Total
Small										
Total cost	55 445	78 097	1 228	4 949	6 137	1 154	4 755	4 380	17 692	173 837
Per cow	33.60	47.33	0.75	3.00	3.72	0.70	2.88	2.65	10.72	105.35
Medium										
Total cost	143 209	379 655	1 977	10 194	31 117	2 495	32 060	15 699	71 256	687 662
Per cow	24.92	66.06	0.34	1.77	5.42	0.44	5.58	2.73	12.40	119.66
Large										
Total cost	196 223	482 783	2 965	12 568	32 481	4 055	17 805	18 503	120 126	887 509
Per cow	23.52	57.87	0.36	1.51	3.89	0.49	2.13	2.22	14.40	106.39
Total										
Total cost	394 877	940 535	6 170	27 711	69 735	7 704	54 620	38 582	209 074	1 749 008
Per cow	27.13	58.17	0.46	2.07	4.50	0.53	3.87	2.57	12.38	111.68

[a]Small herds, <200 cows; medium herds, 200-499 cows; large herds, $\geqslant 500$ cows.
[b]Calves born dead.

TABLE 2

Cost (in U.S. dollars) of disease by category of expenditure and age group on 43 California dairy farms (NAHMS, 1986–87)

Age group[a]	Death	Cull	Weight loss	Veterinary	Drugs	Disposal	Labor	CBD[b]	Milk loss	Total
Calves										
Total cost	36 254	0	1 224	1 142	15 720	1 896	10 345	0	0	66 581
Per calf	1.24	0.00	0.06	0.07	0.49	0.06	0.37	0.00	0.00	2.29
Young stock										
Total cost	43 582	12 819	2 451	618	3 385	970	2 712	0	0	66 537
Per young stock	5.37	1.64	0.20	0.12	0.32	0.16	0.29	0.00	0.00	8.10
Cows										
Total cost	315 041	925 995	2 495	25 951	50 526	4 838	41 497	38 582	209 074	1 613 999
Per cow	21.30	57.17	0.23	1.85	3.39	0.29	3.00	2.58	12.41	102.22
Bulls										
Total cost	0	1 721	0	0	104	0	66	0	0	1 891
Per bull	0.00	5.89	0.00	0.00	0.60	0.00	0.43	0.00	0.00	6.92

[a]Calves are birth to weaning, young stock are weaning to calving. Cows are heifers or cows that have calved once, bulls are males for breeding.
[b]Calves born dead.

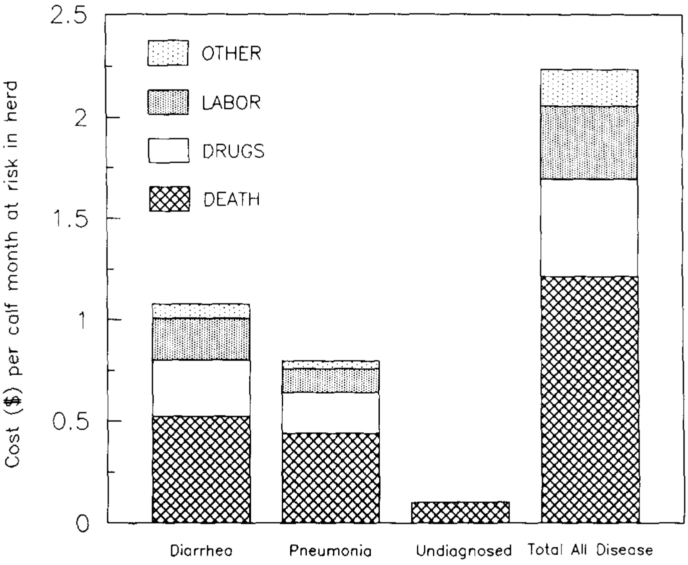

Fig. 1. Cost of diseases affecting calves for 43 California dairies (NAHMS, 1986-87). (Total includes all diseases reported for calves in this study and not just those illustrated.)

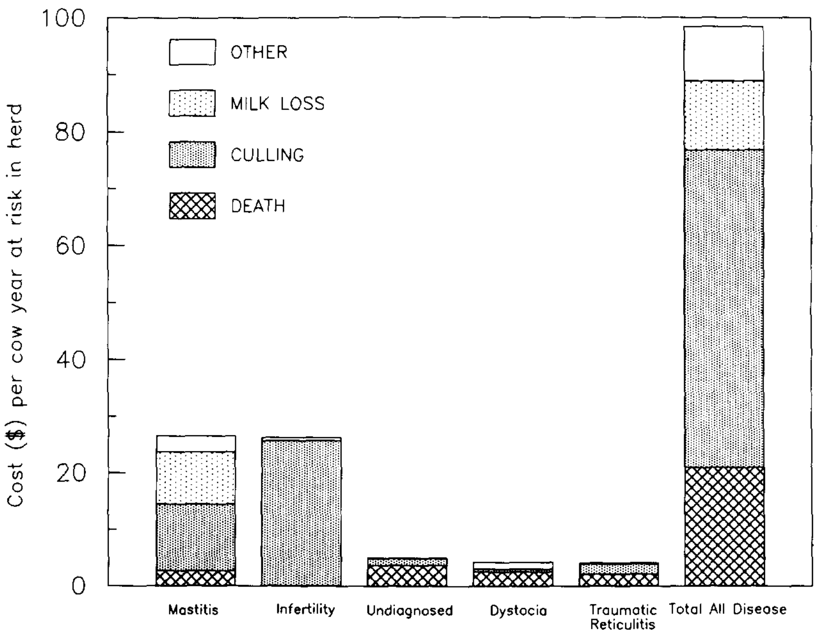

Fig. 2. Cost of diseases affecting cows for 43 California dairies (NAHMS, 1986-87). (Total includes all diseases reported for cows in this study and not just those illustrated.)

65% of the cost of young stock disease. Labor was an important cost associated with calf disease, accounting for 16% of total costs. In cows, culling accounted for 57% of disease costs. Death and milk loss (resulting from contamination of milk with drugs following treatment of cows for disease) accounted for 20 and 13% of the total costs, respectively.

Diarrhea and pneumonia were responsible for 86% of costs of calf diseases (Fig. 1). The cost of calf diarrhea on dairy farms in our study was $33 722, or $1.11 per calf-month ($n=43$). Calf pneumonia cost a total of $23 622 ($0.82 per calf-month). Death loss accounted for the major part of the cost for these two diseases.

Pneumonia in young stock cost $24 642 or $2.05 per young-stock-year. Undiagnosed conditions caused $11 857 in losses, all due to death. This was equivalent to $1.61 per young-stock-year.

Five diseases – mastitis, infertility, disease of unknown etiology, dystocia, and traumatic reticulitis – accounted for 67% of the disease costs for cows (Fig. 2). For the 43 dairies, mastitis cost $460 073 ($27.06 per cow-year) and infertility $425 464 ($26.74 per cow-year). Ninety-eight per cent of the reported costs associated with infertility were the result of culling. For mastitis, 45 and 35% of the costs were due to culling and milk loss, respectively.

Costs associated with prevention of disease

The total amount spent to prevent disease was $171 616, or about 10% of the cost of disease occurrence. Costs were similar among strata (Table 3). For all dairies, more money was spent to purchase biologics or drugs for disease

TABLE 3

Cost (in U.S. dollars) of disease prevention by category of expenditure and herd size stratum for 43 dairies in California (NAHMS, 1986–87)

Herd size stratum	Medication	Labor	Veterinary	Total
Small (<200 cows)				
Total cost	8 898	3 266	3 176	15 340
Cost per cow-yr	5.39	1.97	1.92	9.28
Medium (200–499 cows)				
Total cost	33 748	11 944	21 789	67 481
Cost per cow-yr	5.87	2.08	3.78	11.73
Large (>499 cows)				
Total cost	53 258	7 049	28 488	88 795
Cost per cow-yr	6.38	0.84	3.41	10.63
Total				
Total cost	95 904	22 259	53 453	171 616
Cost per cow-yr	5.86	1.73	3.13	10.72

prevention than for preventive veterinary service or on labor related to disease prevention.

By age category, more money was spent by dairy owners in our study for prevention of disease in cows ($8.95 per cow-year) than for disease prevention in young stock ($1.59 per young-stock-year) or calves ($0.36 per calf-month).

Prevention of mastitis and of infertility accounted for more than 75% of the cost for disease prevention in cows. Eighty per cent of the cost for mastitis prevention was due to the cost of drugs, and the major part of the cost for preventing infertility was for routine rectal examinations. Producers with large or medium-sized herds spent more than twice the amount per cow-year to prevent infertility than producers with small herds.

Miscellaneous costs

For all dairies in our study the three areas of miscellaneous expenditure totaled $5.48 per cow-year; veterinary consultation cost $1.29 per cow-year, milking machine maintenance was $2.94 per cow-year, and nutrition consultation was $1.25 per cow-year.

Variation in producer reporting of disease costs

Between-farm differences in disease costs were great (Table 4), but variation was almost entirely attributable to differences in mortality and culling of affected animals. Values assigned by producers for dead animals varied markedly between and within farms. The mean value of a dead calf for 41 herds reporting deaths was $57.06 (SD = 23.50, range $6–$500). The upper value was for a purebred animal. The mean value of young stock that died was $467.14 (SD = 310.18, range $100–$1200). The mean value of a dead or culled cow was

TABLE 4

Mean and range of reported costs of disease occurrence and prevention for 43 dairies in California (NAHMS, 1986-87)

Disease	Occurrence			Preventive measures	
	No. of herds	Cost[a] (range) ($)	Cost[b] (range) ($)	No. of herds	Cost[c] (range) $
Mastitis	43	103.46 (4.32- 318.30)	2.11 (0.02-10.24)	41	0.37 (0.01-1.23)
Infertility	38	349.59 (5.00-1100)	1.91 (0.02-10.66)	39	0.25 (0.01-1.43)
Calf diarrhea	37	19.94 (0.50- 102.96)	1.24 (0.01- 6.89)	7	0.08 (0.01-0.23)

[a]Expressed per affected animal per herd for herds with cases.
[b]Expressed per cow-month or per calf-month (diarrhea) per herd for herds with cases.
[c]Expressed per cow-month or per calf-month (diarrhea) per herd for herds reporting preventive measures.

TABLE 5

Extrapolation of costs (in U.S. dollars) of important disease conditions to the California dairy industry by herd size (NAHMS, 1986-87)

Disease	Age group affected[a]	Herd size strata[b]			Total
		Small	Medium	Large	
Mastitis	Cows	2 409 447	10 028 714	14 717 359	27 155 520
Infertility	Cows	2 465 481	10 807 331	11 819 532	25 092 344
Unknown	Cows	334 706	1 715 324	3 756 731	5 806 761
Traumatic reticulitis	Cows	394 200	1 674 164	1 840 144	3 908 508
Dystocia	Cows	500 152	1 669 786	1 614 871	3 784 809
Pneumonia	Young stock	136 673	263 897	1 070 770	1 471 340
Diarrhea	Calf	248 068	669 128	1 057 022	1 974 218
Pneumonia	Calf	156 542	583 865	632 301	1 372 708
Unknown	Young stock	261 001	252 156	237 647	750 804
Unknown	Calf	36 837	66 753	81 380	184 970

[a]Calf, birth to weaning; young stock, weaning to first calving; cows, heifers and cows that have calved at least once; bulls, males used for breeding.
[b]Small dairies had <200 cows; medium dairies had 200-499 cows; large dairies had ⩾500 cows.

$973.60 (SD=221.70, range $350–$2500). Extremely valuable cows were purebred animals.

Extrapolation of costs to California dairies

Estimated total milk production for California based on our study was 6.95×10^9 kg. At an average price of $11.70 per 45 kg, the value of milk production was estimated to be $\$1.81 \times 10^9$. The total annual cost of disease, disease prevention, and miscellaneous costs for California's dairies was estimated to be $118.8 million, or 6.6% of the milk production value.

Extrapolated costs from specific diseases for all California dairy farms by herd size are shown in Table 5. Mastitis and infertility were the most costly diseases and together accounted for an estimated loss of $52.2 million. Undiagnosed conditions in the cow cost $5.8 million. When all age categories were combined, losses due to undiagnosed conditions were more than $6.7 million.

The extrapolated costs for prevention of mastitis and infertility for the study year for all California dairies were $4 million and $2.8 million, respectively.

DISCUSSION

The NAHMS was conceived to provide accurate morbidity and mortality rates for the livestock industry in the U.S.A. It was also meant to determine the "economic impact of economically significant disease and conditions of food-producing animals in the United States ... [and] ... evaluate costs of diseases or conditions, costs of preventing or ameliorating these problems, and the cost–benefits of the surveillance project itself" (King, 1985). The goals of the program implied in these statements are not only documentation of costs associated with disease but also application of these data to evaluation of management systems in protection against disease. An evaluation of the NAHMS and its ability to use economic data must focus on these two goals.

Evaluation of study design

Did the study design of the NAHMS allow the economic estimates reported here to be sufficiently precise and valid? Stratified random sampling of dairies with proportional allocation based on herd size was used in the present study. This scheme was chosen because it offered improved precision over simple random sampling for estimation of some production parameters measured on California dairies (Akhtar et al., 1988). Based on results of Akhtar et al. (1988), good precision of estimates was likely if about 80 herds were sampled. Ultimately, the number of dairies selected for our study ($n=45$) was determined by available personnel from the government agencies involved in the data collection.

Recruitment of as many of the selected dairies as possible was important to ensure valid estimates with the error bounds and sample size selected. We enrolled 53% of the dairies in our original sample. Replacements were obtained by recruiting the dairy that was geographically closest to the originally selected dairy and was similar in herd size. This method of selecting replacement herds was chosen to maintain the balance of personnel allocation required by the cooperating agencies. The distribution of herd sizes in the final sample differed slightly from the original sample because some herd-size data in the Dairy Cattle Data Base (DCDB) list were outdated, some replacement herds were not in the same stratum as the originally selected herd, and two herds dropped out. We did not obtain data comparing refusals with the alternative dairies selected; therefore, it was not possible to determine whether selection bias occurred.

The data reported here depended on producer reporting of disease and cost of disease. The strength of this system was that the observer/recorder of disease events was part of the daily operation of the dairy. Producer reporting also ensured that diseases which were readily detected by the farmer were emphasized. Such reporting generally overlooked subclinically affected animals. Another potential weakness was misclassification of disease, because reported disease was mostly based on producer observation, with little confirmation of diagnosis by veterinarians or diagnostic laboratories.

Validating costs of prevention and disease

Incoming field data and reported results were evaluated to ensure their validity. For field data, our main purpose was to determine whether the observed within- and between-farm differences in costs of labor and value of animals were real. When extreme values were detected, the values were checked with the VMO involved in data collection on the farm. Values represented opportunity costs. As an example, a zero labor cost for treating mastitis was usually associated with treating cows in the milking parlor. The owner believed that the time spent treating the cow did not slow the milking process and hence was not a cost. Another owner in the same situation may have perceived that treatment slowed milking and hence considered it a labor cost. In these cases, the variation was justified and represented real cost differences. The same conclusions held for culling and death costs; variation between farms represented true values. Much of the variation in the costs of occurrence of mastitis, female infertility, and calf diarrhea were attributed to differences in culling and mortality within and among farms. Costs were high when animals died or were culled but relatively low when animals were treated and recovered.

Validation of results was done in two ways. Milk production estimates were compared with known milk production for California. For the same time period as our NAHMS survey, milk production on Grade A California dairies was approximately 7.64×10^9 kg (Anon., 1988). For our sample, which included 38 Grade A and five Grade B dairies, the estimate was 6.95×10^9 kg.

Cost estimates for clinical mastitis and reproductive problems were compared with previous reports of disease costs. In the present study, mastitis and infertility were the two most costly diseases; occurrence and prevention were estimated to cost \$31.24 and \$29.55 per cow-year, respectively. A study based on NAHMS data in Ohio reported costs of \$48.29 per cow for mastitis and \$25.38 per cow for infertility (Miller and Dorn, 1987). Dobbins (1977) has reported costs due to mastitis (excluding production loss) of \$28.79 per cow (not corrected for inflation). Although values for the three studies were similar, all studies failed to include the cost of production loss due to clinical and subclinical disease. Only 20% of cost associated with mastitis is due to clinical disease and 80% is due to lost milk production (Dobbins, 1977).

The cost of infertility can be divided into short-term losses as a result of disease treatment (labor, veterinary care, drugs,culling) and milk production loss as a result of increased days open (increased days milking in late lactation plus yield decreases in following lactation) (Louca and Legates, 1968; Holmann et al., 1984). One study found that economic loss (including production loss) resulting from infertility could be as high as \$138 per cow (Morales et al., 1987). Lost milk production because of infertility was not considered in our study.

We believe our results are an accurate representation of the cost of clinical conditions to dairy farmers in our sample. The estimation of economic impact of subclinical disease and rare diseases was not attempted in this study. The true cost of disease is likely to be substantially higher than we estimated.

Reporting results

Economic loss in our study was reported as cost per animal-year or calf-month. This method allowed for more accurate reporting of the data and automatically corrected data for follow-up of less than 12 months. Although it is different from reporting the cost per animal per year, the values are equivalent in interpretation and should not pose a problem in reporting to the producer.

One of the explicit goals of the NAHMS is to assess the cost of disease to the food-animal industry. The extrapolated costs of disease to the California dairy industry reported in our study were calculated with the knowledge that several potential flaws existed in the study design. Subclinical disease was not accounted for, diagnoses were validated infrequently, the precision of estimates of costs was not known, and selection bias could have existed. These extrapolated values were included because they represented the best available estimates of disease costs to the California dairy industry.

Recommendations for NAHMS directions in future studies

Merely reporting costs associated with disease should be a minor part of the NAHMS. Extensive data based on clinical syndromes are of limited use to the animal industry. It may not be necessary to repeat studies every year to monitor temporal changes in the nature of losses to producers. Data may only need to be gathered every 3–5 years for the same industry. In addition, more knowledge needs to be acquired to assist in determining sample size and sampling strategies required for accurate economic estimates. Every effort must also be expended to recruit a high proportion of randomly selected farms into the program provided that data quality is not compromised.

More effort should be directed towards obtaining verified diagnoses and towards measuring subclinical disease. This will require more effective and creative use of existing data systems (such as DHI records) and other new methods.

Evaluation of effectiveness of management procedures in preventing losses associated with disease has received little attention in the NAHMS, but it could be argued that it should be the major focus of the NAHMS economic studies. Given the existing study design, a limited comparison of management methods could be obtained if more attention were given to obtaining background information on management from participating farms.

Extrapolation of costs from the NAHMS studies to produce industry-wide estimates of losses should be reviewed carefully. There are two assumptions in this practice that influence the value of these estimates. The first assumption is that the disease can be eradicated or that all costs due to the disease can be recovered completely (Morris and Meek, 1980). For the major diseases under study in the NAHMS, i.e. mastitis and infertility, this is unlikely to occur. The second assumption – which may be invalid – is that the value of animal and production loss will be unchanged if diseases are controlled or eliminated industry-wide. As production expands because of improved disease prevention (ceteris paribus), prices will decline and impact on producers is indeterminant (Miller et al., 1988). Violation of these assumptions may diminish the value of these industry-wide estimates of disease loss.

The value of any program is determined by how well its users are served. In our study the user group was the California dairy industry. The data we provided are novel for California and fill an information gap on the impact of disease on industry profits. However, problems in study design and in execution (recruitment of dairies, inability to measure subclinical disease) may limit value of the data to industry.

ACKNOWLEDGEMENTS

The authors wish to thank the veterinarians from the U.S. Department of Agriculture and the California Department of Food and Agriculture, Division of Animal Health, who collected the field data. M. Smargiassi and M.J. Fanelli provided invaluable assistance with data handling and checking. J. Holmes wrote the computer programs for data entry and analysis. This study was supported by APHIS–USDA Cooperative Agreement No. 12-16-98-019.

APPENDIX 1

Definitions of disease costs

Costs associated with disease events

Death: (number of deaths per month) × (producer-estimated value of each animal).

Cull: [replacement cost (based on the producer-estimated market value for a replacement animal of the same age, sex, and breed as the culled animal)] – (price received for the culled animal).

Weight loss: cost of the extra amounts of feed, labor, and housing to return the animal to normal weight, by producer estimate. In practice, this definition usually was meant to apply to young stock but occasionally was extended to calves and cows.

Veterinary: veterinary services provided for an animal affected by a disease or condition, obtained from invoices to the producer.

Drugs: cost of drugs used by the producer to treat a condition. Cost of drugs used by veterinarians to treat affected animals was included in veterinary costs.
Disposal: carcass removal and any associated producer labor costs.
Labor: (hours of labor by producer) × (producer estimate of per hour labor value).
Calves born dead: producer-estimated value of a live calf, assuming that male and female calves were born in equal numbers. In practice, this category included all stillbirths but rarely accounted for aborted fetuses.
Milk loss: supposedly determined as a producer estimate of decreased production as a result of an illness, or as the amount of milk discarded because of drug contamination following treatment of disease. In practice, producers rarely attempted to estimate production loss; consequently, the milk loss estimate reflected only the value of discarded milk. The value of milk was determined as the average value paid for milk sold.

Costs associated with disease prevention
Drugs: drugs or biologics used for prevention of disease and labor associated with their purchase.
Labor: on-farm costs associated with disease prevention, defined as (time spent for on-farm disease prevention activities) × (average value of labor).
Veterinary services: costs of veterinary service provided for preventive measures, as obtained from invoices provided by the veterinarian to producer.

Miscellaneous costs
Veterinary consultation: cost for consultation on general herd health and management.
Milking machine maintenance: routine maintenance of milking machines.
Nutrition consultation: included fees charged for ration formulation, feeding management, commodity purchasing, and feed testing.

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